

Milk characteristics and cheese yield of Holsteins and 3-breed rotational (ProCross) crossbred cows

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Introduction

- crossbreeding of dairy cattle is on the rise globally because of declining fertility, health and survival of pure Holstein
- most of the research focused on effects of crossbreeding on cow fertility, health, milk production and composition
- effects of crossbreeding on milk characteristics, cheese yield and cheese characteristics have not been properly explored



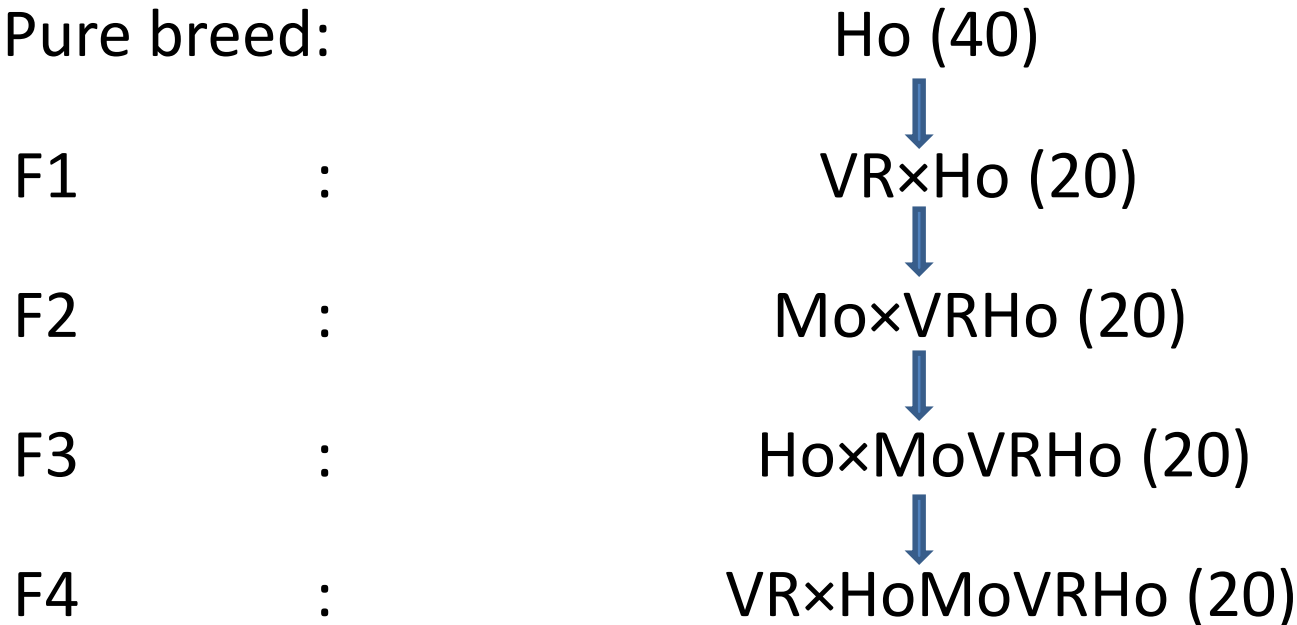
Objectives

- To investigate the effect of 3-way rotational crossing of Holstein (Ho) cows with Viking Red (VR), Montbeliarde (Mo) and Ho sire on
 - milk composition, casein micelle and fat globule
 - coagulation traits
 - cheese yield and
 - cheese characteristics (physical and chemical)

Materials and Methods

- A farm from northern Italy following a **3-breed rotational crossbreeding (ProCross) scheme** since > 10 years
- **120** multiparous cows (100 - 300 DIM; MY 32 ± 7.9 kg/d):

Pure breed:



Materials and Methods

- individual milk samples (2 L) from evening milking collected (6 weeks, 20 cows/week) and analyzed for:
 - milk composition (Milkoscan FT2)
 - casein micelle and fat globule (Mastersizer 2000)
 - milk coagulation properties (Lactodynamographs)
 - model cheese manufacture (Cipolat-Gotet et al., 2016):
 - ✓ Cheese yield, weight and composition
 - ✓ cheese physical traits (color – Minolta colorimeter and texture analysis – TA.XTplus texture analyzer)

Statistical analysis

- Data were analyzed by using a mixed model:
 - Fixed effects: parity (2), DIM (3) and breed combinations
 - Random effect: Date of sample analysis (6)
- orthogonal contrasts estimated between LS means of traits for the effect of breed combinations:

HO vs crosses (F1+F2+F3+F4)

VR sire: (F1+F4) vs (F2+F3)

Mo sire: F2 vs (F1+F3+F4)

Ho sire: F3 vs (F1+F2+F4)

RESULTS

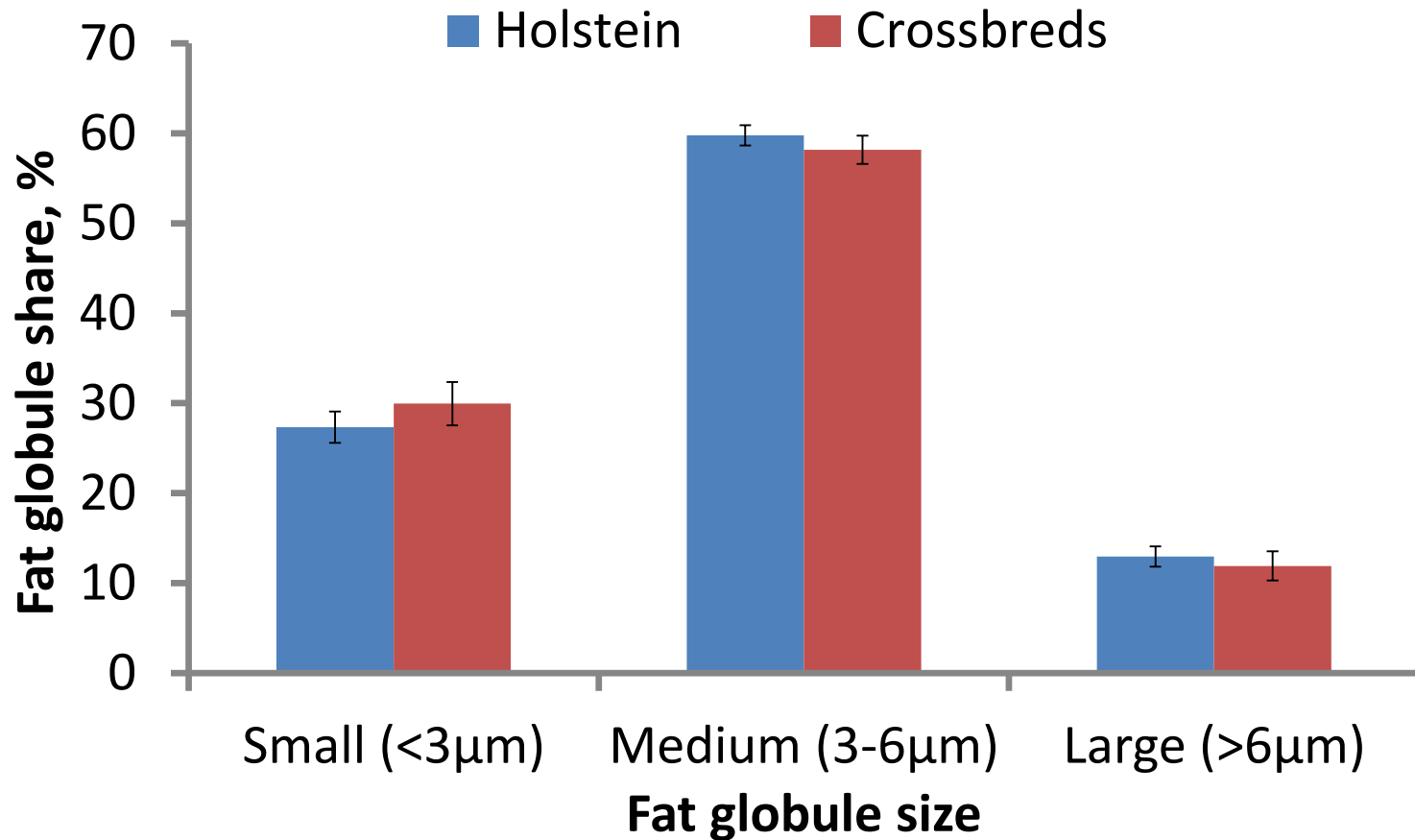


Milk composition and casein micelle size

Item	Fat, %	Prot, %	Lact, %	SCS	Cas. Mic. size, nm
Ho	4.40	3.90	5.03	3.30	125.8
F1 VR×Ho	4.56	4.16	4.95	2.30	123.8
F2 Mo×VRHo	4.21	3.90	4.94	2.91	123.0
F3 Ho×MoVRHo	4.23	3.92	5.03	3.07	125.3
F4 VR×HoMoVRHo	4.55	4.15	4.90	2.42	124.7
SEM	0.28	0.08	0.04	0.39	1.03
(avg crosses)	4.39	4.03	4.96	2.68	124.2
Contrasts, P value:					
Ho vs cross(F1+F2+F3+F4)	ns	0.03	0.008	0.03	0.03
VR sire: (F1+F4) vs (F2+F3)	ns	0.002	0.09	0.08	ns
Mo sire: F2 vs (F1+F3+F4)	ns	0.03	ns	ns	0.09
Ho sire: F3 vs (F1+F2+F4)	ns	0.07	0.01	ns	ns

Fat globule size and share (%)

size	Ho	Crossbreds	Statistics
d43, μm	3.87	3.74	ns
d32, μm	3.36	3.29	ns



d43= volume- weighted average diameter, d32=volume-surface average diameter

Milk coagulation properties

Item	RCT, min	K20, min	a30, mm	a45, mm	a60, mm
Ho	25.03	6.52	26.64	34.11	36.99
F1 VR×Ho	23.12	4.63	32.19	40.10	40.30
F2 Mo×VRHo	26.81	6.38	27.41	33.93	38.41
F3 Ho×MoVRHo	23.76	5.87	29.77	36.66	36.98
F4 VR×HoMoVRHo	25.42	5.71	24.62	38.63	40.90
SEM	2.22	0.65	4.28	2.68	1.93
(avg crosses)	24.78	5.65	28.50	37.33	39.15
Contrasts, P value:					
Ho vs cross(F1+F2+F3+F4)	ns	0.10	ns	0.10	0.10
VR sire: (F1+F4) vs (F2+F3)	ns	ns	ns	ns	0.08
Mo sire: F2 vs (F1+F3+F4)	0.09	ns	ns	0.10	ns
Ho sire: F3 vs (F1+F2+F4)	ns	ns	ns	ns	ns

Curd yield and nutrient recovery traits

Item	Fresh curd yield, %			Recovery, %	
	Total	Solids	Water	Protein	Fat
Ho	17.47	7.03	10.47	77.43	79.77
F1 VR×Ho	19.25	7.56	11.69	78.21	81.79
F2 Mo×VRHo	16.81	6.79	10.03	76.41	77.62
F3 Ho×MoVRHo	17.60	6.97	10.62	77.53	79.75
F4 VR×HoMoVRHo	18.22	7.39	10.82	78.19	79.16
SEM	0.62	0.27	0.45	0.43	1.34
(avg crosses)	17.97	7.18	10.79	77.58	79.58
Contrasts, <i>P</i> value:					
Ho vs cross(F1+F2+F3+F4)	ns	ns	ns	ns	ns
VR sire: (F1+F4) vs (F2+F3)	0.01	0.04	0.01	ns	0.01
Mo sire: F2 vs (F1+F3+F4)	0.01	0.09	0.01	ns	0.04
Ho sire: F3 vs (F1+F2+F4)	ns	0.01	ns	ns	ns

Cheese weight and chemical composition

Item	Weight, g		Composition (%DM)		
	Fresh	After 70 d	DM	Protein	Fat
Ho	265	157	68.4	39.4	46.4
F1 VR×Ho	292	170	69.1	38.9	47.2
F2 Mo×VRHo	255	148	68.3	40.6	45.1
F3 Ho×MoVRHo	268	157	68.9	39.7	45.8
F4 VR×HoMoVRHo	277	163	68.0	40.7	45.0
SEM	9.23	5.06	0.64	0.92	1.13
(avg crosses)	273	160	68.6	40.0	45.8
Contrasts, P value:					
Ho vs cross(F1+F2+F3+F4)	ns	ns	ns	ns	ns
VR sire: (F1+F4) vs (F2+F3)	0.01	0.01	ns	ns	ns
Mo sire: F2 vs (F1+F3+F4)	0.01	0.01	ns	ns	ns
Ho sire: F3 vs (F1+F2+F4)	ns	ns	ns	ns	ns

Physical traits of cheese

Item	Color			Textural Characteristics		
	L*	a*	B*	Hardness,N	Cohsiv	Elast. ind
Ho	81.8	-0.8	14.5	24.15	0.72	0.83
F1 VR×Ho	82.2	-0.7	13.9	26.28	0.72	0.82
F2 Mo×VRHo	81.4	-0.8	15.0	24.53	0.74	0.82
F3 Ho×MoVRHo	81.1	-1.0	14.4	25.23	0.71	0.86
F4 VR×HoMoVRHo	81.2	-0.8	14.4	25.07	0.72	0.82
SEM	1.07	0.16	0.37	2.84	0.02	0.01
(avg crosses)	81.5	-0.8	14.4	25.28	0.72	0.83
Contrasts, P value:						
Ho vs cross(F1+F2+F3+F4)	ns	ns	ns	ns	ns	ns
VR sire: (F1+F4) vs (F2+F3)	ns	ns	ns	ns	ns	ns
Mo sire: F2 vs (F1+F3+F4)	ns	ns	0.07	ns	ns	ns
Ho sire: F3 vs (F1+F2+F4)	ns	0.08	ns	ns	ns	0.02

L* = lightness, a* = redness, b* = yellowness

Conclusions

- when compared to purebred HO, crossbred cows showed:
 - > protein content and lower SCS
 - smaller casein micelle size and comparable fat globule size
 - slightly better curd firmness
 - comparable curd and cheese yield
 - comparable physical and chemical traits of cheese
- differences among different crossbred generations (VR sired cows: greater protein content and cheese yield; Mo sired crossbred cows opposite trends)
- next step: sensory evaluation of cheese

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Thank you for your attention!

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Any Questions?



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